

Next-Generation Bioacoustic Analysis Software

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LONG-TERM GOALS

In the past two decades, awareness has grown that acoustic methods are often the best means for studying and monitoring marine mammals. Acoustic methods, for instance, have long been used for detection and study of sperm whales, in part because of the difficulty of visual detection: Visual surveys have been estimated to miss 38% of sperm whales that are on a ship's trackline (Barlow and Rankin 2004), and more at greater distances from the trackline. Other species are similar or worse; for instance, it is estimated that approximately 85% of Cuvier's beaked whales on the trackline are missed with visual scanning (J. Barlow, pers. comm). Acoustic methods, in contrast to visual ones, function well in darkness, fog, high sea states, and other inclement viewing conditions. Via the use of autonomous recorders, acoustic methods can also be used in remote or inhospitable areas (Širović et al. 2004, Mellinger et al. 2008) where visual monitoring would be impracticable or impossible. Software tools are needed for analyzing such data sets, even for such simple tasks as manually scanning spectrograms to find calls of interest. Acoustic localization of calling animals is often performed; whether estimates are in one dimension (bearing), two (X-Y position), or three (X-Y-Z position), analysis software is necessary. Marine mammal acoustic data is often collected in very large data sets, necessitating automated methods for data analysis. For instance, AURAL autonomous recorders (Multi-Électronique, Inc.) operate at a sample rate of 32 kHz, so that a one-year data set is 2 terabytes (TB) in size. Another type of autonomous recorder, the HARP (Wiggins 2003; J. Hildebrand, pers. comm.), operates at even higher sample rates – up to 200 kHz – making a one-year data set 12.6 TB in size. Automation tools are clearly needed for data sets of this scale.

Starting in 2000, ONR funded the development of one such tool, Ishmael (Mellinger 2001). It is a user-friendly bioacoustic analysis package for Windows. It includes displays of sound waveforms and spectrograms, recording capability for real-time input, several methods for acoustic localization, beamforming, several methods for automatic call recognition, and a sound annotation facility. Ishmael is aimed at users wishing to analyze large volumes of data quickly and easily. Ishmael quickly became popular, with thousands of downloads by users; a large proportion those downloads were in active use, and a survey in 2005 showed that 46% of respondents use it regularly. It has also been used in much ONR-funded research.

In this project, we will implement a number of improvements and updates to Ishmael.

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OBJECTIVES

- Hire and train a software engineer to make improvements to Ishmael.
- Implement new audio I/O.
- Implement improved localization.
- Implement improved detection and classification.
- Implement improved acoustical measurements.
- Implement programming interfaces.
- Update Ishmael's documentation for these improvements.
- Create user group / web site for users to share information and tips.

APPROACH

The approach is to hire a software engineer to perform most of that above tasks in collaboration with myself. Research assistants will also perform much of the updating of documentation.

WORK COMPLETED

The software engineer, Jonathan (Jon) Dodge, was hired and started work on Ishmael in early December 2010. Training began immediately by my showing him how Ishmael worked, what classes and data structures it uses, how it interfaces to Windows and to the world, etc. This was an extended effort, with Jon starting to work on updates to Ishmael within a couple of months but still needing to ask frequent questions about Ishmael's workings.

To date, Jon (with occasionally assistance from me) has done the following:

- Made Ishmael compatible with new versions of the development environment (Borland/Embarcadero).
- Made Ishmael operate successfully on Windows Vista, Windows 7 (both 32-bit and 64-bit).
- Made Ishmael operate successfully on the Mac, via the "WINE" wrapper that implements (most of) a Windows programming interface.
- Made Ishmael work with new versions of National Instruments data acquisition hardware. This fixed a major roadblock to the use of Ishmael, as it previously worked only with now-outdated hardware.
- Made it possible to play sounds back during an analysis run. Before, one had to stop the run to play sounds, requiring either missing new real-time data or re-starting at the very beginning of the sound file.
- Made it possible to extract date/timestamps from file names using wildcards. This was useful because many people make recordings and put their date/time information into their filenames, and Ishmael can now parse these filenames and extract the date/time information flexibly.

- It is now possible to make a selection in multichannel data, and the part that gets played back will be from the selected channel.
- Caused configuration information to be displayed in the title bar.
- Increased string consistency across the 8-bit and 16-bit versions of characters.
- Fixed a number of bugs: in the way sampling rates were being displayed in sound card I/O, as well as playback rates; in the paths that were being generated for saving recorded sounds; in loading files incorrectly when there was extra whitespace in filenames; a reported memory leak; in loading configuration files from network shares; in storing spectrogram correlation contour parameters; in saving folder names where recorded sounds are to be stored; in producing a warning dialog when Ishmael reads preferences and encounters an invalid write directory; in saving configuration files; in an algorithm error that caused detection functions to become negative in the energy sum detector; and several more minor bugs.

RESULTS

Ishmael is much more up-to-date than it has been for several years.

The new version of Ishmael has been put on the web site (<http://www.bioacoustics.us/ishmael.html>) and was used for the *Introduction to Detection, Classification, and Localization* tutorial at the Mt. Hood DCLDE workshop. Also, a poster and live demonstration was given at the Mt. Hood DCLDE workshop; the abstract for this is as follows:

Dodge, J., D.K. Mellinger, H. Klinck. 2011. Ishmael 2.0: An improved software package for detection and localization of marine mammal vocalizations. Book of Abstracts, Fifth International Workshop on Detection, Classification, Localization, and Density Estimation of Marine Mammals using Passive Acoustics, 21-25 August 2011, Mt. Hood, Oregon, p. 70.

IMPACT/APPLICATIONS

Ishmael is used for marine mammal acoustic monitoring in many places around the world. Having an up-to-date version, particularly with regard to real-time sound I/O, was a much-needed step in making such monitoring usable and accessible.

RELATED PROJECTS

Advanced Methods for Passive Acoustic Detection, Classification, and Localization of Marine Mammals (award numbers N0001411IP20086 and N0001411WX21401). This ONR-funded effort is developing improved algorithms that will be offered to users in a user-friendly way by implementing them in Ishmael in the future.